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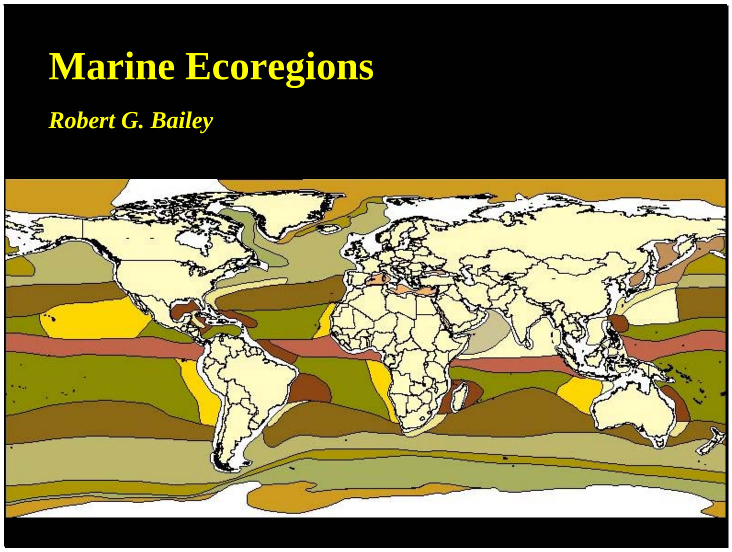

Marine Ecoregions

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Draft of 7/20/2006 8:44 PM

Abstract: Oceans occupy some 70% of the Earth's surface. In a hierarchical sense, they are the environment of the continental systems embedded within, controlling their behavior. Understanding continental systems requires a grasp of the enormous influence that marine systems exert on terrestrial climatic patterns and thus the character and distribution of continental ecoregions. The intent of this paper is to analyze factors affecting the distribution of the Earth's major marine ecoregions. The objective is to go beyond empirical description by suggesting mechanisms that are responsible for producing the world pattern. Ecoregions recur in similar form in various parts of the world. Because of this predictability, we can transfer knowledge gained about one region to another.

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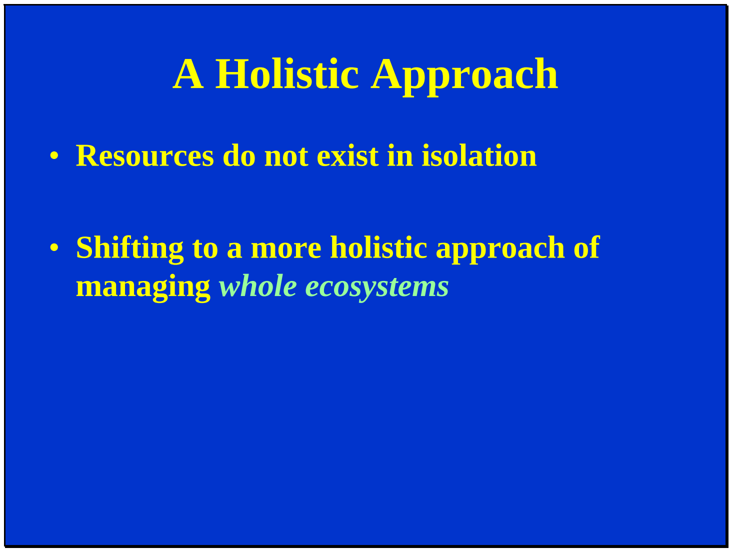

More and more there is growing realization that the natural resources do not exist in isolation, but interact with each other. Understanding this, has led to a shifting of focus to a more holistic approach of managing *whole ecosystems.*

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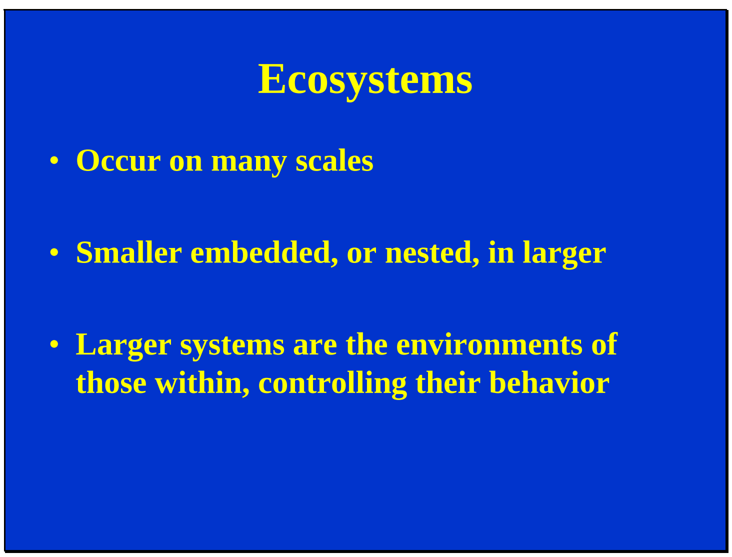

Ecosystems
Ecosystems occur on many scales: oceans to frog ponds. The smaller systems are embedded, or nested, in the larger systems. The larger systems are the environments of those within, controlling their behavior.

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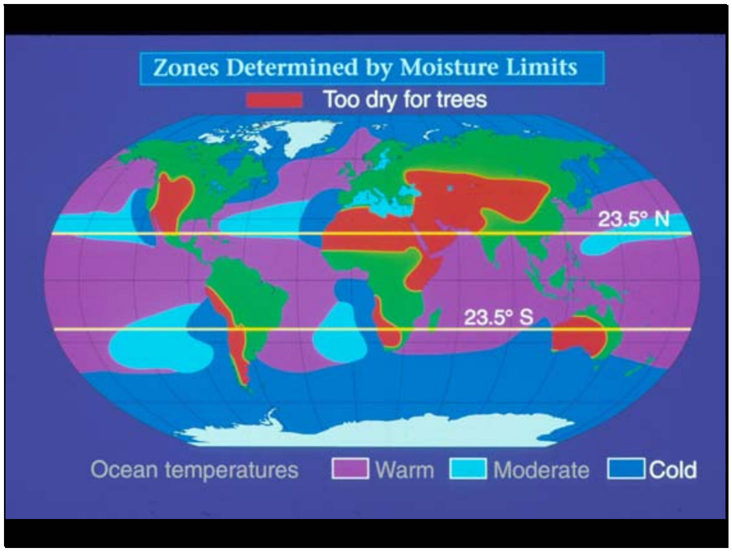

For example, on the macro scale, the continents are embedded in the oceans that influence the continental climate patterns. There is more precipitation over the margins of continents bathed by warm water. The fact that we have warm-water currents along the East Coast of the U.S. explains why the mid-latitude deserts of the Southwest do not extend completely across North America.

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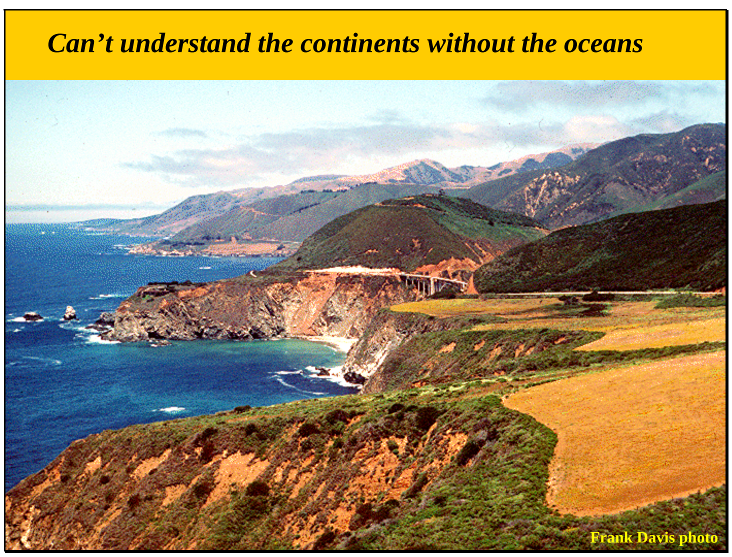

Therefore, one can't understand the ecosystem patterns of the continents without understanding the oceans. Over the last 20 years, marine influences over terrestrial systems have been increasingly recognized: El Nino/La Nina cycles influencing droughts, the interaction of marine-land systems in global climate change scenarios, and the Atlantic thermo-halide current and its potential role in starting and ending ice ages. [**Note:** There are also enormous influences that the continents have on the oceans, such are land use patterns that increase sediment or impoundments that decrease it. But that is the subject of another presentation.]

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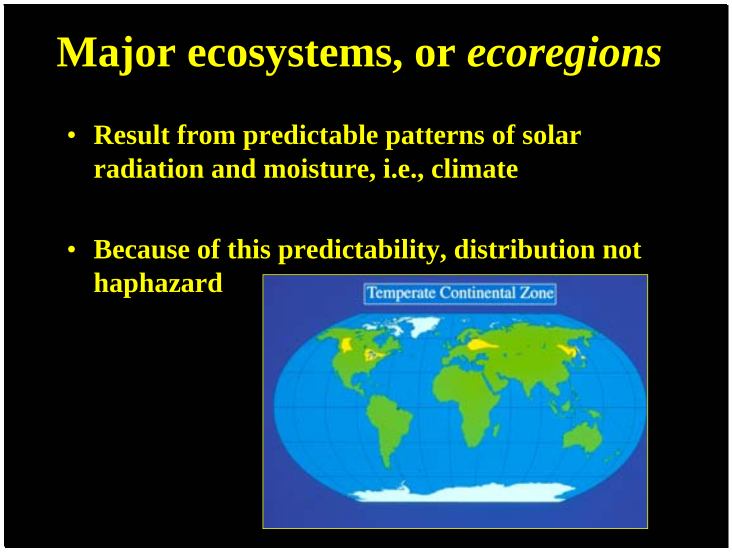

Major ecosystems, or ecoregions, result from predictable patterns of solar radiation and moisture. Because of this predictability, their distribution in not haphazard; they form regular patterns, recurring in similar form in various part of the world (cf., Bailey 1996). For instance, in the northern hemisphere, temperate continental ecoregions are always located in the interior of continents and on the leeward, or eastern, sides; therefore, the northeastern United States is ecologically similar to northern China, Korea, and northern Japan.

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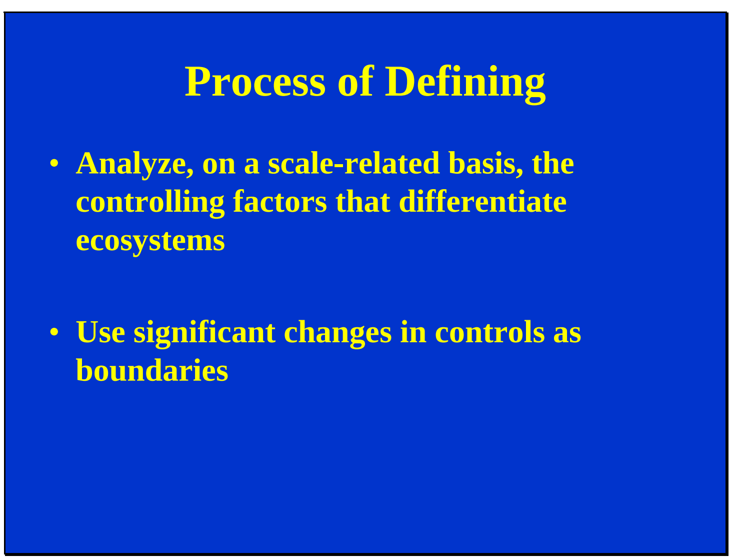

How can the boundaries of the various size systems be determined? The defining concept is to use an approach based on controls. Therefore one analyzes, on a scale related basis, the controlling factors that differentiate one ecosystem from another. Then we use significant changes in those controls as criteria for boundaries.

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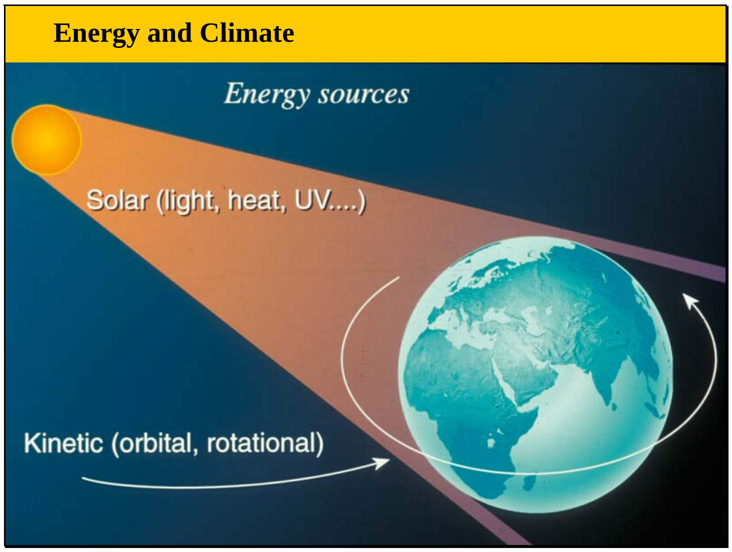

Energy and Climate

Energy is the prime driving force and controller of conditions on Earth. The three main sources of energy are solar radiation, providing heat and light, the kinetic energy of the rotation and orbit of the Earth, and the internal forces of both heat and energy. Climate, as a source of energy and water, acts as the primary control for ecosystem distribution. As the climate changes, so do ecosystems.

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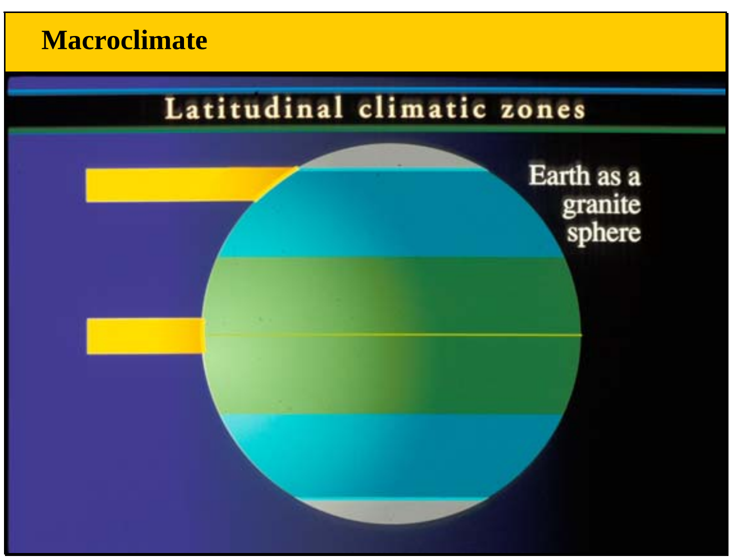

Macroclimate

The low latitudes receive more solar radiation. To balance this energy there is a large scale transfer of heat poleward through oceanic and atmospheric circulation. If the Earth had a homogeneous surface this would result in circumferential climatic zones, or *macroclimates*, related to latitude.

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However, because the Earth's surface consists of oceans as well as large masses of land and polar ice, the macroclimate distribution becomes more comples.

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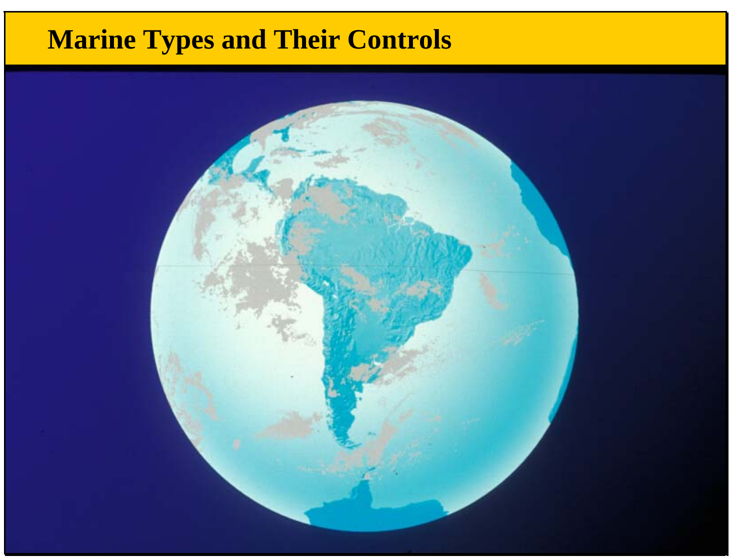

Marine Types and Their Controls

Oceans occupy some 70% of the Earth's surface and extend from the North Poles to the shores of Antarctica. There are great differences in the character of the oceans, and these differences are of fundamental importance, both in the geography of the oceans themselves, and to the climatic patterns of the whole Earth. The surface of the ocean is differentiated into regions, or zones, with different hydrologic properties resulting from unevenness in the action of solar radiation and other phenomena of the climate of the atmosphere.

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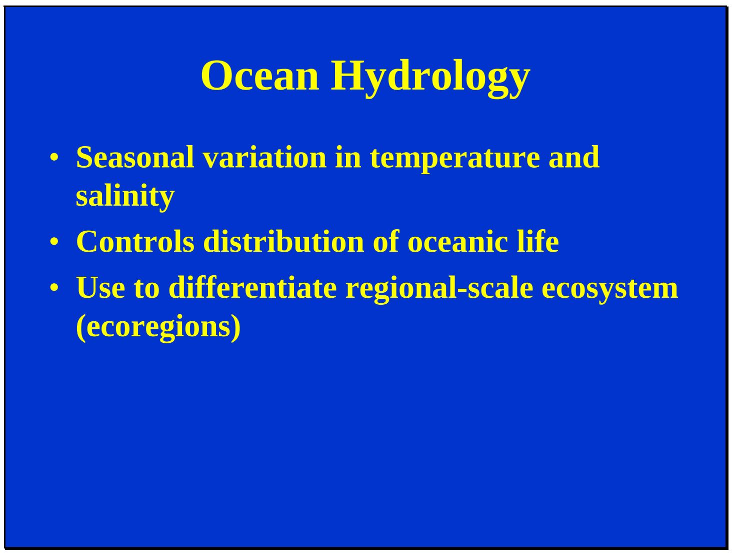

Ocean Hydrology
Ocean hydrology may be defined as the seasonal variation in temperature and salinity of the water. It controls the distribution of oceanic life. We use ocean hydrology to differentiate regional-scale ecosystems, or ecoregions.

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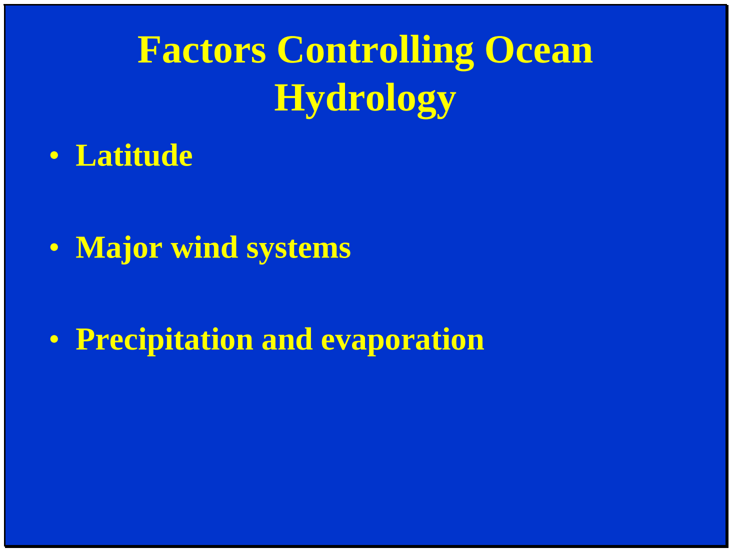

Factors Controlling Ocean Hydrology
To establish the hydrologic zones of the world's oceans, we must determine the boundaries. Our approach is to analyze those factors that control the distribution of zones, and to use significant changes in those controls as the boundary criteria. The distribution in the character of the oceans is related to three factors: latitude, major wind systems, and precipitation and evaporation.

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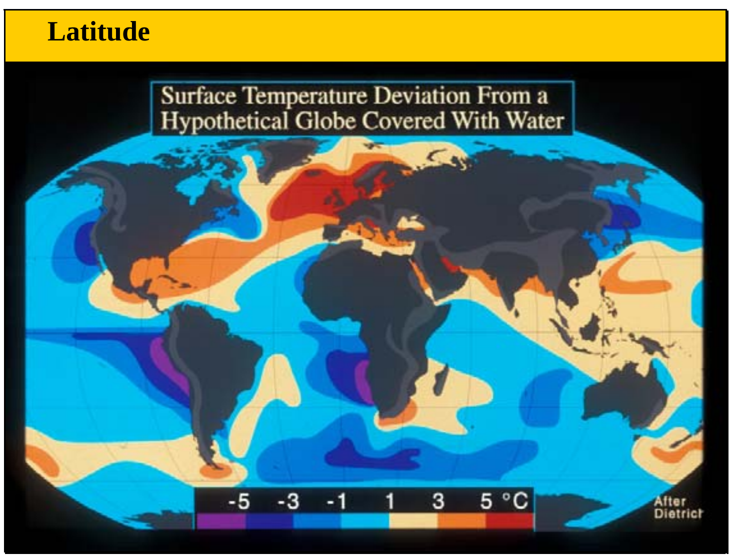

Latitude
Heating depends predominantly on latitude. If the Earth were covered with water only, there would be circumferential zones of equal ocean temperature. The actual distribution forms a more complicated pattern. Water temperatures range from well over 27C (80F) in the equatorial region, to below 0C at the poles . Areas of higher temperature promote higher evaporation and therefore higher salinity.

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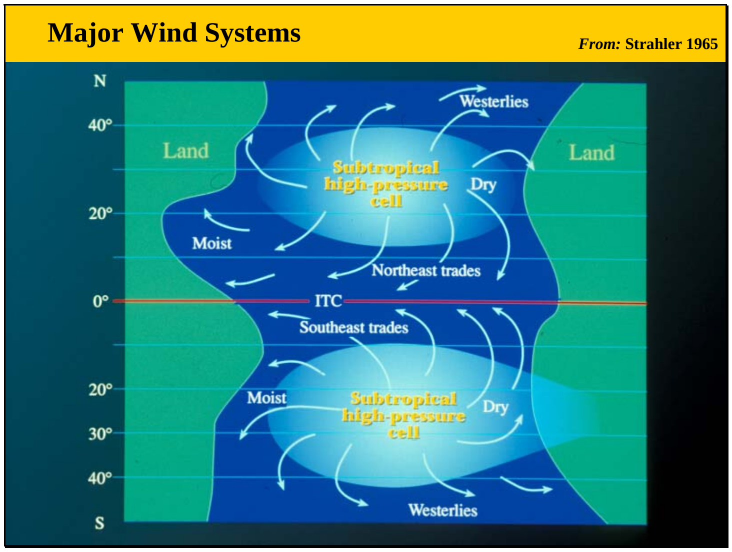

Major Wind Systems
Prevailing surface winds set surface currents in motion and modify the latitudinal orientation of thermal zones. The most important are those know as *oceanic whirls*, centered at about 30 degrees north and south latitude, around the subtropical high-pressure cells.

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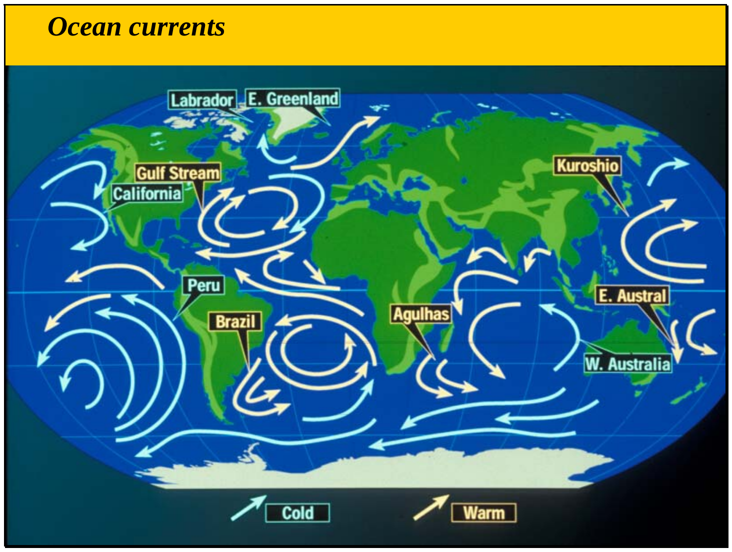

Ocean currents
Prevailing surface winds generally move warm water toward the poles and cold water toward the tropics in large scale circulation patterns. They move clockwise in the northern hemisphere and counterclockwise in the southern.

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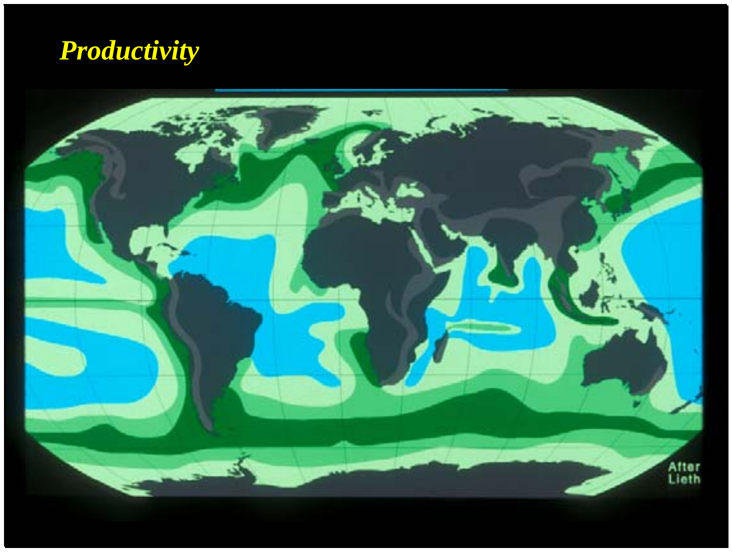

Productivity
The earth’s rotation, tidal swelling, and density differences further contribute to the dynamics of the oceans, both at the surface and with depth. Distribution and diversity of ocean life are subsequently affected. Abundance is generally higher in areas of cooler temperatures and areas of upwelling of nutrients.

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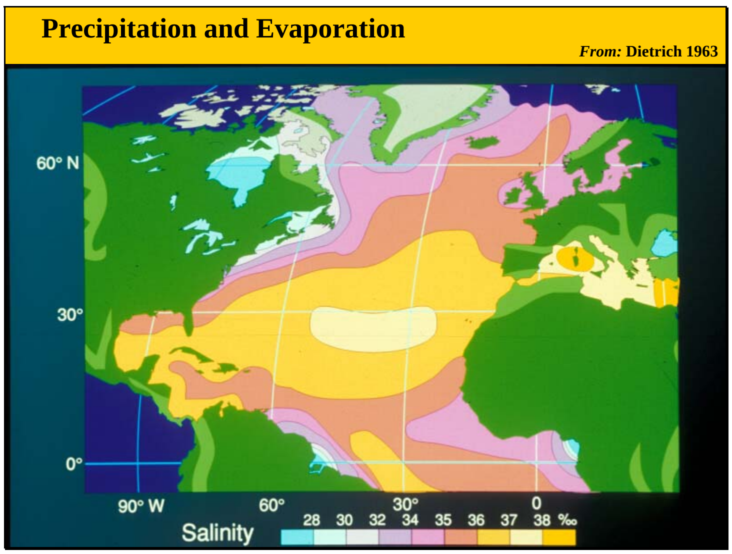

Precipitation and Evaporation
Surface salinity is affected by rates of precipitation and evaporation. Heavy rainfall lowers salinity by dilution; evaporation increases it. Near the equator heavy rainfall lowers salinity by dilution; evaporation increases it in the subtropics.

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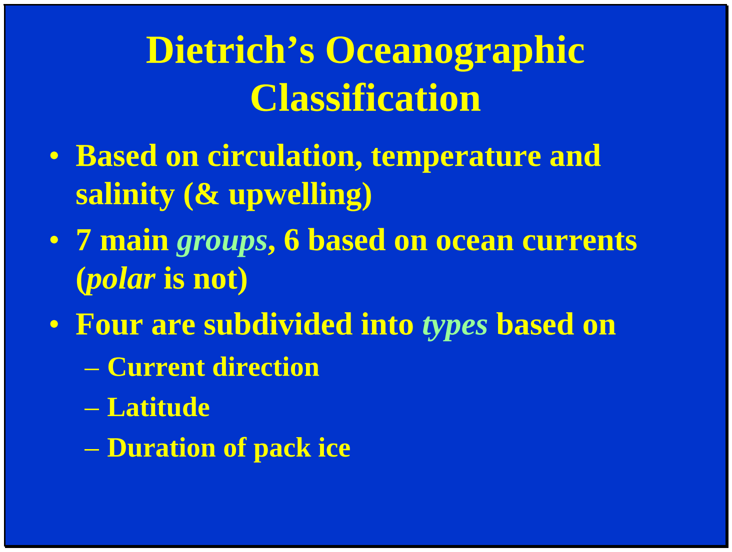

Types of hydrologic zones, or ecoregions
The interaction of the oceanic macroclimates and large-scale ocean currents determine the major hydrologic zones, or marine ecosystems. Their boundaries are determined following a scheme adapted from Schott and Dietrich.

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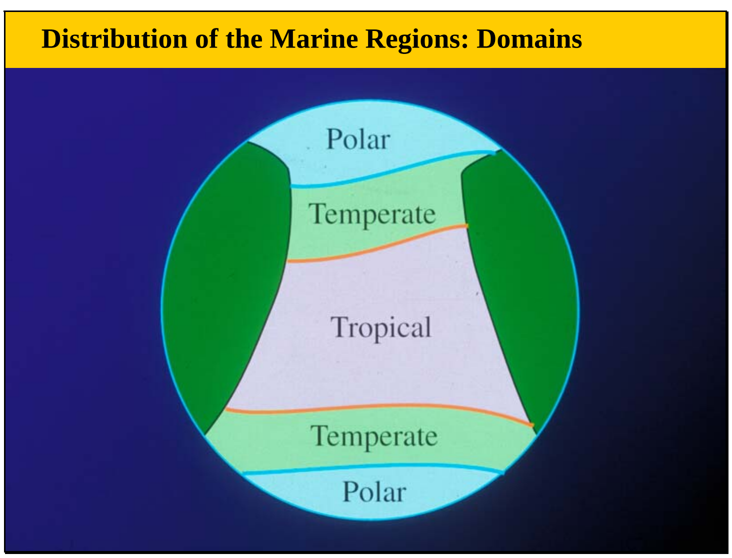

Distribution of the Marine Regions: Domains
There are three primary groups, or *Domains*, based on contrasting types of water. As shown in a hypothetical ocean basin, the three groups are: polar, with cold water and ice; tropical, with warm water; and temperate, with mixed water.

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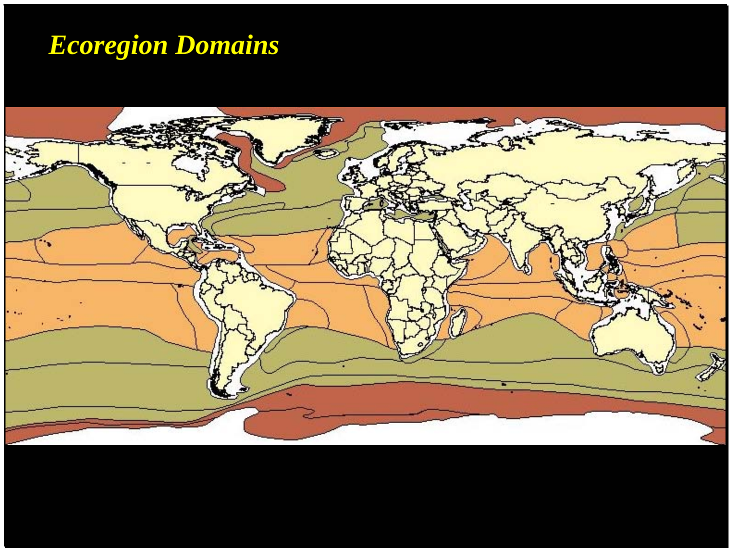

Here are the marine ecoregion domains.

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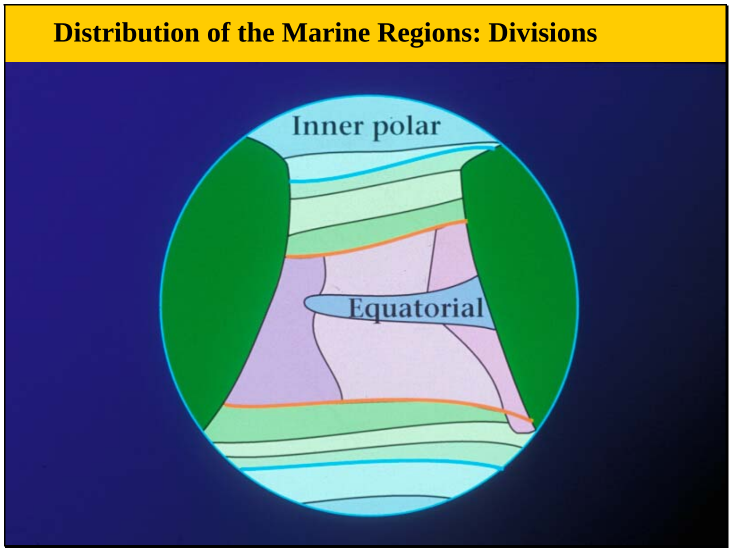

Distribution of the Marine Regions: Divisions
The oceanic Domains are further subdivided into 14 *Divisions*, using a system of regional classification by Dietrich, which are differentiated on the basis of circulation, temperature, salinity, and the presence of upwelling. They range from the inner polar division at high latitudes to the equatorial division at low latitudes.

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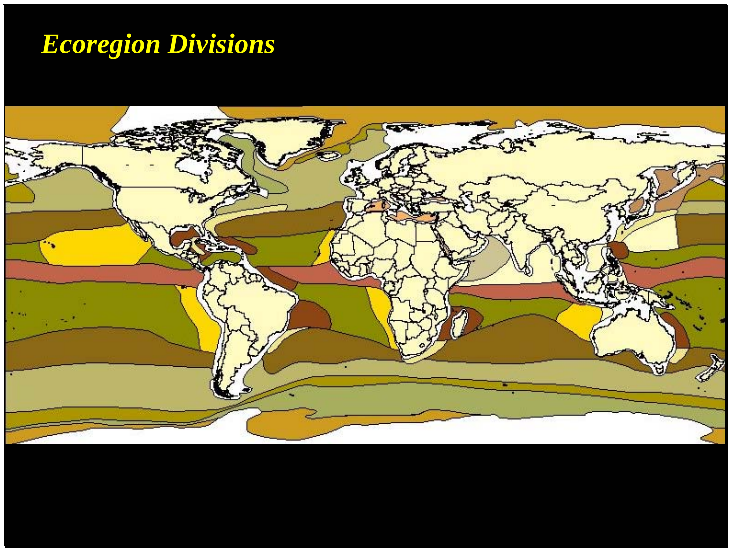

And this is a map of the marine ecoregion divisions.

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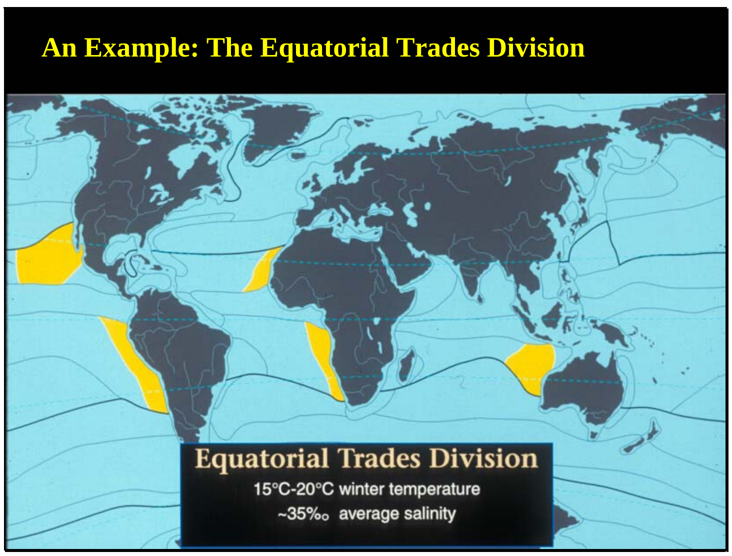

An Example: The Equatorial Trades Division
Each domain/divisions occurs in several different parts of the world that are broadly similar with respect to physical and biological characteristics. For example, the equatorial trades is characterized by upwelling with winter temperatures ranging from 15-20C and average salinity of about 35 parts per million.

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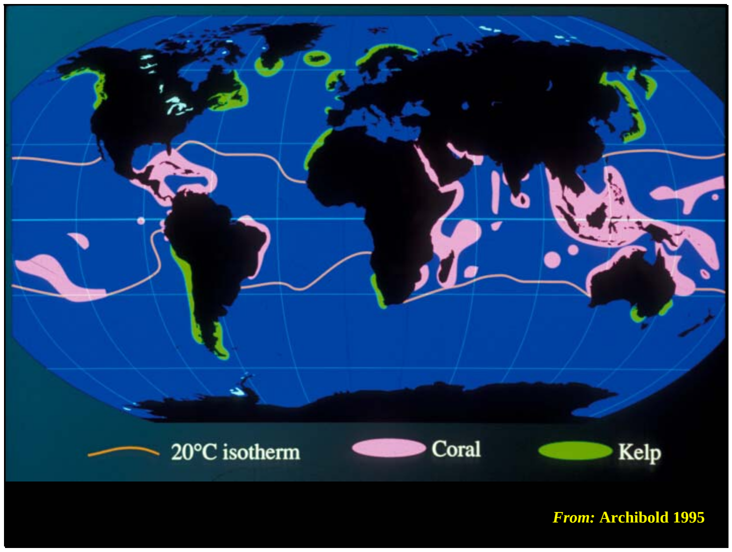

A consequence of the low surface temperature of these regions is the fact that no coral reefs are found in these areas. Their development requires not only clear water but also temperatures of at least 20C in the coldest month of the year.

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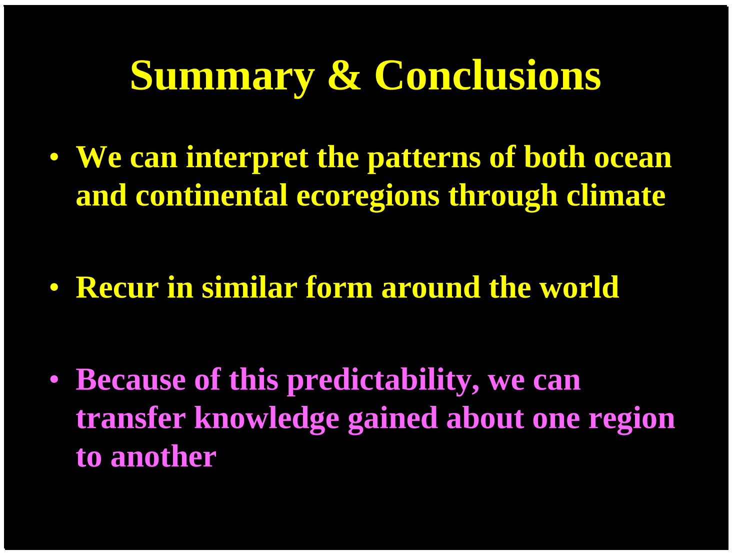

Summary and Conclusions
We can interpret the patterns of both ocean and continental ecoregions through climate. Ecoregions recur in similar form in various parts of the world. Because of this predictability, we can transfer knowledge gained about one region to another.

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For More Information:

Bailey, R.G. (1998) *Ecoregions: The Ecosystem Geography of the Oceans and Continents*. Springer.
The causes, character, and pattern of the major ecosystems. Includes two folded maps in pocket.
Dietrich, G. (1963) *General Oceanography: An Introduction*. John Wiley.

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